

Engineering Design File

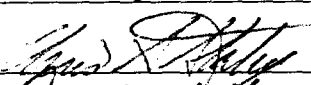

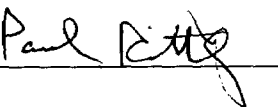
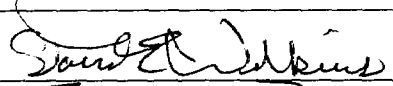

PROJECT NO. 23927

Air Emissions Evaluation for the Accelerated Retrieval Project for a Described Area within Pit 4



ENGINEERING DESIGN FILE

EDF No.: 4692 EDF Rev. No.: 0 Project File No.: 23927

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5. Summary:				
This engineering design file presents an evaluation of radiological, criteria, and toxic air pollutant emissions from the planned Accelerated Retrieval Project for a Described Area within Pit 4 of the Radioactive Waste Management Complex at the Idaho National Engineering and Environmental Laboratory. Based on calculations documented in this engineering design file, project emissions from the Accelerated Retrieval Project will not result in violation of allowable emission rates or ambient air quality standards associated with Federal Clean Air Act requirements or Idaho Administrative Procedures Act, "Rules for the Control of Air Pollution in Idaho." The project will not result in any adverse health effects to workers outside the retrieval facility or to the public.				
6. Review (R) and Approval (A) and Acceptance (Ac) Signatures: (See instructions for definitions of terms and significance of signatures.)				
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ACRONYMS

AACC	acceptable ambient concentration for carcinogens
ARF	airborne release factor
ARP	Accelerated Retrieval Project
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFA	Central Facilities Area
DOE	U.S. Department of Energy
EBR-I	Experimental Breeder Reactor I
EDE	effective dose equivalent
EDF	engineering design file
EPA	U.S. Environmental Protection Agency
HEPA	high-efficiency particulate air
IDAPA	Idaho Administrative Procedures Act
IDEQ	Idaho Department of Environmental Quality
INEEL	Idaho National Engineering and Environmental Laboratory
MAR	material at risk
MEI	maximum exposed individual
NESHAP	National Emission Standard for Hazardous Air Pollutants
NOAA	National Oceanic and Atmospheric Administration
RFP	Rocky Flats Plant
RWMC	Radioactive Waste Management Complex
SDA	Subsurface Disposal Area
TAP	toxic air pollutant
TRU	transuranic
VOC	volatile organic compound

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Air Emissions Evaluation for the Accelerated Retrieval Project for a Described Area within Pit 4

1. INTRODUCTION

1.1 Purpose

The purpose of this engineering design file (EDF) is to document calculations that estimate radiological, criteria, State of Idaho toxic-air-pollutant (TAP) emissions, and resulting impacts associated with the Accelerated Retrieval Project (ARP) for a described area within Pit 4 at the Radioactive Waste Management Complex. The ARP is a Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) (42 USC § 9601 et seq., 1980) non-time-critical removal action to retrieve and manage selected Rocky Flats Plant (RFP)^a waste from a portion of the Subsurface Disposal Area (SDA) within the RWMC at the Idaho National Engineering and Environmental Laboratory (INEEL). The area of focus is approximately 1/2 acre in size and is located in the eastern portion of Pit 4 of the SDA (see Figure 1). The specific retrieval area was selected by evaluating the shipping and burial records for containerized radioactive material and sludge from the RFP and low-level radioactive waste generated at the INEEL.

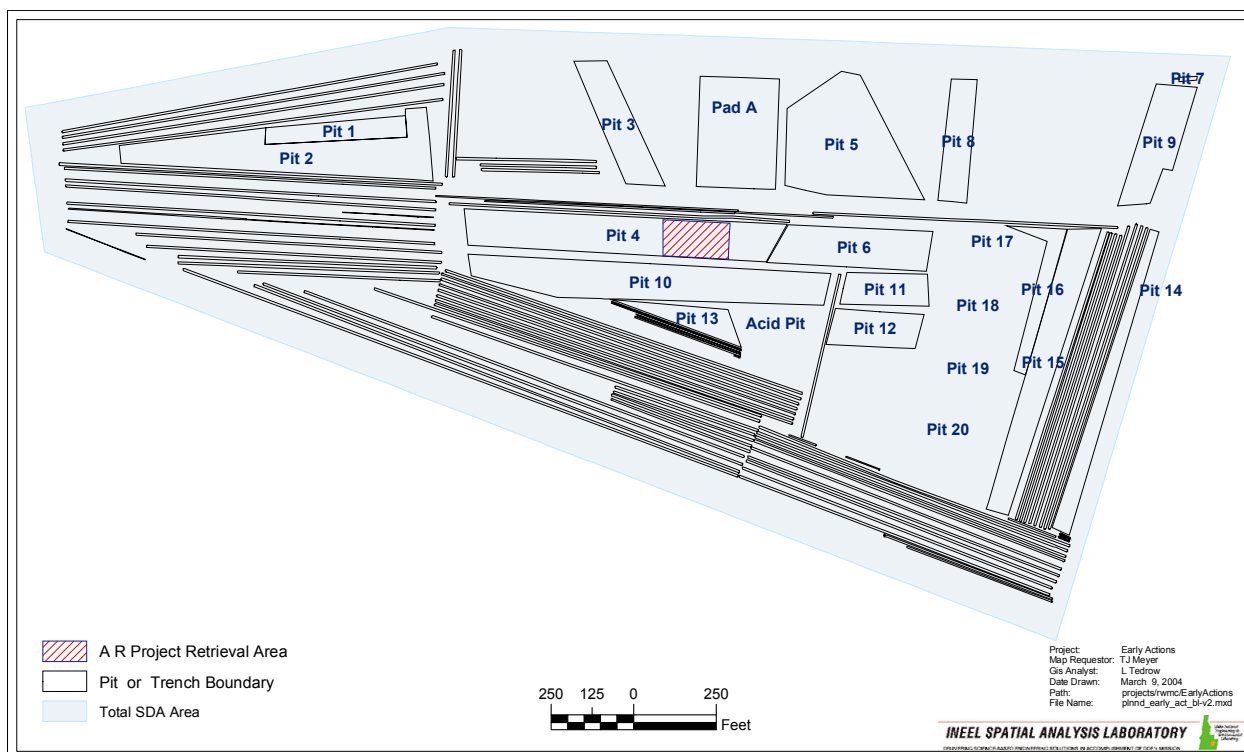


Figure 1. Graphic depiction of the Radioactive Waste Management Complex showing the Accelerated Retrieval Project described area within Pit 4.

a. The RFP is located 26 km (16 mi) northwest of Denver. In the mid-1990s, it was renamed the Rocky Flats Environmental Technology Site. In the late 1990s, it was again renamed, to its present name, the Rocky Flats Plant Closure Project.

The retrieval process will consist of the following activities:

- Removing clean overburden
- Excavating a layer of potentially contaminated soil above the waste zone material
- Excavating waste zone material and retrieving waste that is visually determined to be transuranic (TRU) waste (e.g., graphites, filters, and Series 741 sludge) or to contain contaminants of concern (e.g., volatile organic compounds [VOCs] in Series 743 sludge or uranium isotopes in roaster oxide)
- Packaging retrieved waste into drums
- Assaying and segregating drums into TRU (greater than 100 nCi/g) and non-TRU (less than or equal to 100 nCi/g)
- Treating VOCs as required^b
- Following interim storage, dispositioning waste at the Waste Isolation Pilot Plant in Carlsbad, New Mexico, or other final disposition sites as required.

This work will be performed inside the Retrieval Enclosure, a large fabric enclosure constructed over the retrieval area to reduce spread of contamination and provide protection from the weather. Various characterization, sampling, and packaging systems will be used to prepare waste for final disposition. Project execution strategies have been developed for safety, procurement, quality, environmental protection, radiation protection, industrial health and safety, configuration management, security, and construction. A complete description of the proposed project is available in the *Engineering Evaluation/Cost Analysis for the Accelerated Retrieval of a Designated Portion of Pit 4* (DOE-ID 2004).

Objectives of this air emissions evaluation include performing the following actions:

1. Estimate conservative radionuclide TAP and criteria-pollutant atmospheric emission rates from Retrieval Enclosure leakage and from the high-efficiency particulate air (HEPA) -filtered stack during excavation. (Note: Accident releases were not evaluated.)
2. Perform a downwind dose assessment for radionuclide emissions using the U.S. Environmental Protection Agency (EPA) CAP-88 dose assessment model to demonstrate compliance with (a) 40 CFR 61, "National Emission Standard for Hazardous Air Pollutants," (NESHAP) (i.e., 10 mrem/year dose standard for abated emissions and 0.1 mrem/year emissions-monitoring criteria for unabated emissions) and (b) allowable dose impacts identified in *Manual 15A - Radiation Protection - INEEL Radiological Control Manual* and 10 CFR 835, "Occupational Radiation Protection Exposure." Two receptors evaluated were (a) a hypothetical maximum exposed individual (MEI) member of the public residing 7,976 m south-southwest of the RWMC (identified as Frenchman's Cabin) and (b) an RWMC worker located immediately downwind of the Retrieval Enclosure exhaust stack and vent.

b. Emissions estimates for any treatment processes are not included in this report, but will be performed in the future to support the next system design.

3. Perform air-dispersion modeling for TAP and criteria-pollutant emissions to determine appropriate time-averaged maximum ambient air concentrations at public-access-receptor locations specified in the Idaho Administrative Procedures Act (IDAPA), "Rules for the Control of Air Pollution in Idaho," (IDAPA 58.01.01) and for a maximum exposed RWMC worker. Compare maximum ambient air concentrations to State of Idaho TAP screening increments given in IDAPA 58.01.01.585-586 and Idaho and National Ambient Air Quality Standards. Compare the RWMC worker exposure to occupational exposure limits as established by the American Conference of Governmental Industrial Hygienists (ACGIH 1999). For TAPs, calculate maximum short-term health impacts (i.e., cancer risks) for members of the public at the public-access location with the highest air concentrations (Experimental Breeder Reactor I [EBR-I]) and the maximum exposed RWMC worker.

2. METHODS

2.1 Source-Term Development

Development of the ARP source term was documented in EDF-4428, "Estimating Radioactive Airborne Concentrations for the Accelerated Retrieval Project for a Described Area within Pit 4"; EDF-4591, "Waste Categories and Characteristics for the Accelerated Retrieval Project for a Described Area within Pit 4"; and EDF-4825, "Retrieval Enclosure Wind Leakage Calculations for the Accelerated Retrieval Project for a Described Area within Pit 4." Source-term development included (1) identification of contaminants present in the waste, (2) a reasonable prediction of high-end-contaminant concentrations that might be encountered during excavation, (3) estimation of fractions of various waste types exposed during excavation, (4) estimation of airborne release fractions for exposed waste, and (5) calculation of the amount of contaminants leaked from the enclosure and discharged through the HEPA-filtered ventilation system (EDF-4825).

2.2 Assessment of the Radiological Source Term

Most waste buried in the retrieval area came from processing of weapons-grade plutonium and its decay products at the RFP, primarily during 1966. The remaining waste is nominally from the INEEL; however, some of that waste may have originated from other laboratories around the United States. Waste forms from the RFP contain various radiological and nonradiological contaminants. Material shipped to Pit 4 from RFP included plutonium and uranium isotopes. Plutonium isotopes included Pu-238, Pu-239, Pu-240, Pu-241, and Pu-242. Uranium isotopes (i.e., U-234, U-235, U-236, and U-238) were shipped to RWMC in the form of depleted uranium oxides. Also included in waste shipments were Am-241 and trace quantities of Np-237. Isotopes Am-241 and Np-237 are daughter products resulting from radioactive decay of Pu-241. In addition to the Am-241 produced by decay of Pu-241, Am-241 removed from plutonium during processing at RFP was also buried in Pit 4. This extra Am-241 is a significant contributor to the total radioactivity in Pit 4. Other radionuclides (e.g., Co-60, Cs-137/Ba-137m, and Sr-90/Y-90), primarily from INEEL waste generators, are also expected to be encountered in the project area. Non-RFP waste streams include radioactively contaminated sewage sludge and combustible- and noncombustible-debris waste forms (DOE-ID 2004).

Airborne release rates were estimated (EDF-4428), assuming that all waste in the retrieval area would be excavated and retrieved within a single calendar year. Table 1 lists the estimated total activity for each radionuclide that would be released into the air during a single calendar year during waste retrieval. The total activity for each radionuclide is the resulting activity after 39 years of decay (EDF-4591), exposure of an assumed fraction of material, and application of an airborne release factor (ARF). Fractions and factors used in the airborne release calculations (EDF-4428) are as follows:

- **Exposed material at risk:** This is an assumed fraction of waste that actually could become exposed for possible release to the air, and is expressed as a percentage of a waste container's contents. For sludge, the exposure fraction is assumed to be 5%; for filter waste, graphite waste, and all other waste categories, the exposure fraction is assumed to be 20%.
- **Airborne release factor:** The ARF is that fraction of exposed material at risk (MAR) that actually becomes suspended in air. The ARF depends on the state of the waste and how tightly bound the radioactive material is within the waste form. The ARF values used in this report are from U.S. Department of Energy (DOE) Handbook, "Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities" (DOE-HDBK-3010-94) as cited in EDF-4428. For sludge waste, the average ARF was estimated to be 2E-06; for the filter waste, 2E-03; and for

graphite waste and all other waste categories, 2E-04. However, 100% of the H-3, C-14 (assumed as CO₂), radon isotopes, and I-129 (I-129 assumed to be a gas) from the exposed MAR is assumed to be released (ARF = 1.0).

- **Release from the Retrieval Enclosure:** The calculated leakage rate from the Retrieval Enclosure is 0.5% (EDF-4825); the remainder of contaminants exit through a dioctylphthalate-tested, HEPA-filtered ventilation system.

Table 1. Radionuclide emission rate from excavation and handling of waste before high-efficiency particulate air filtration.

Nuclide	Total Nuclide Release Rate (Q) (Ci/Year)	Nuclide	Total Nuclide Release Rate (Q) (Ci/Year)	Nuclide	Total Nuclide Release Rate (Q) (Ci/Year)	Nuclide	Total Nuclide Release Rate (Q) (Ci/Year)
Am-241 ^a	8.18E-02	I-129	2.58E-08	Pa-234m	3.70E-05	Ra-228	6.33E-16
Pu-238	8.23E-03	Cs-137	3.06E-06	Pb-209	1.12E-07	Rn-219	4.51E-05
Pu-239	2.59E-01	Ac-225	1.12E-07	Pb-210	6.05E-12	Rn-220	1.42E-10
Pu-240	5.79E-02	Ac-227	1.87E-10	Pb-211	1.86E-10	Rn-222	4.93E-06
Pu-241	2.91E-01	Ac-228	6.33E-16	Pb-212	5.75E-16	Th-227	1.84E-10
Pu-242	5.42E-06	At-217	1.12E-07	Pb-214	2.00E-11	Th-228	5.76E-16
U-233	6.30E-05	Ba-137m	2.89E-06	Po-210	6.05E-12	Th-229	1.13E-07
U-234	7.61E-06	Bi-210	6.04E-12	Po-211	5.08E-13	Th-230	2.45E-09
U-235	6.35E-07	Bi-211	1.86E-10	Po-212	3.68E-16	Th-231	6.34E-07
U-238	3.70E-05	Bi-212	5.75E-16	Po-213	1.10E-07	Th-232	8.09E-16
H-3	8.75E-04	Bi-213	1.12E-07	Po-214	2.00E-11	Th-234	3.70E-05
C-14	7.87E-05	Bi-214	2.00E-11	Po-215	1.86E-10	Tl-207	1.86E-10
Fe-55	3.44E-08	Fr-221	1.12E-07	Po-216	5.75E-16	Tl-208	2.07E-16
Ni-59	5.49E-09	Fr-223	2.58E-12	Po-218	2.00E-11	Tl-209	2.43E-09
Ni-63	1.91E-04	Np-237	5.83E-07	Ra-223	1.86E-10	U-236	4.46E-07
Co-60	3.06E-09	Pa-2331	4.62E-10	Ra-224	5.75E-16	U-237	7.13E-06
Sr-90	2.39E-05	Pa-233	5.80E-07	Ra-225	1.13E-07	Y-90	2.40E-05
Tc-99	8.33E-10	Pa-234	5.92E-08	Ra-226	2.00E-11	—	—

a. Total Am-241 equals the sum total of original Am-241 and the Am-241 resulting from beta decay of Pu-241.

2.3 Assessment of the Nonradiological Source Term

2.3.1 Nonvolatile Contaminants

Nonvolatile contaminants were assumed to be suspended with soil as particulate. A generic emission rate for particulate matter from soil excavation activities was developed using the *National Pollutant Inventory Emission Estimation Technique Manual*, Version 2.3 (NPI 2001) and a volume estimate of disposed and retrieved materials from the retrieval area of Pit 4, obtained from Table 5-1 of

the *Conceptual Design Report for the Accelerated Retrieval Project at Area G of Pit 4 within the Radioactive Waste Management Complex* (Austad 2004). The quantity of buried material is estimated as

- Overburden—3,300 yd³
- Potentially contaminated soil—2,000 yd³
- Waste zone—9,235 yd³.

The default emission factor from the National Pollutant Inventory (NPI 2001) for excavators, shovels, and front-end loaders for overburden of 0.012 kg/ton (0.0264 lb/ton) was used in determining hourly and annual emission rates of particulate matter resulting from soil-excavation activities. The emission rate for particulate-matter emissions from soil-excavation activities is calculated in Table 2.

Table 2. Particulate matter emissions resulting from waste and soil excavation activities.

Pollutant	Volume of Soil Disposed (yd ³)	Mass of Soil ^a Disposed (ton)	NPI Emission Factor (lb/ton)	Hourly ^b Emission (unabated) (lb/hour)	Hourly ^c Emission (abated) (lb/hour)	Annual ^d Emission (unabated) (ton/year)	Annual ^c Emission (abated) (ton/year)
Particulate matter (as a measure of nonvolatile pollutants)	14,535	24,564	0.0264	0.65	3.45E-03	0.33	1.75E-03

a. Mass of soil disposed = (soil volume 14,535 yd³) × (soil density of 2 g/cm³ (i.e., 1.69 ton/yd³).

b. Hourly unabated emission rate = (mass of soil disposed) × (NPI emission factor) × (1/excavation timeframe of 1,000 hour).

c. Hourly/annual abated emission rate = ([hourly/annual unabated emission rate] × [5E-03 leakage]) + ([hourly/annual unabated emission rate] × [HEPA filter mitigation (i.e., 3E-04)]).

d. Annual unabated emission rate = (mass of soil disposed) × (NPI emission factor) × (1 ton/2,000 lb) × (1/1 year).

Note: Up to 0.5% of emissions from excavation activities may leak from the Retrieval Enclosure unabated (EDF-4825); the remainder will be exhausted through a single stack or vent subsequent to HEPA filtration.

HEPA = high-efficiency particulate air

NPI = National Pollutant Inventory

Because distribution of contaminants potentially present within the Pit 4 retrieval area is not well defined, the abated particulate-emission values from Table 2 are used as an estimate of total nonvolatile contaminants during operations, which are assumed to occur within a single year. Thus, the calculated abated emission rates and resulting ambient concentrations are compared to the IDAPA 58.01.01.585 and .586 screening-emission levels and acceptable ambient concentrations, assuming that the entire particulate emission is representative of the IDAPA TAP for which a comparison is made.

2.3.2 Volatile Contaminants

Carbon tetrachloride (CCl₄) is the VOC present in the greatest abundance in the retrieval area, and CCl₄ is also the VOC possessing the most restrictive emission or concentration limit. As a result, under any reasonable scenario for the retrieval area excavation, CCl₄ will be the VOC most likely to result in a detrimental impact. This assumption is consistent with the findings of air emission modeling for the OU 7-10 Glovebox Excavator Method Project (EDF-2322), which concluded that modeled emission of CCl₄ resulted in more than 98% of the total risk from all contaminants. As a result, CCl₄ represents the only volatile contaminant of concern relative to ARP excavation activities. The estimated annual and short-term average emission rates for CCl₄ for the ARP area retrieval activities are calculated to be

1.95 g/second (highly conservative assumptions) and 2.05 g/second (moderately conservative assumptions) (see Appendix A).

2.3.3 Diesel Exhaust Emissions

Diesel exhaust emissions were evaluated for three sources: (1) two Gradall XL-5200 excavators, each rated at 175 hp and (2) a Tele-Handler TH-103 all terrain forklift with a peak rating of 105 hp. Emission calculations presented in this EDF assume simultaneous operation of all diesel-fired equipment; thus, a total horsepower rating of 455 is assumed for emission calculation purposes. Criteria and TAP emissions were estimated using AP-42 (EPA 1998) emission factors for gasoline and diesel industrial engines (i.e., internal combustion engines greater than 600 hp). Calculated maximum emission rates and resulting maximum ambient air concentrations for criteria and TAPs are determined to demonstrate that emissions from the ARP will not

- Cause an increase in emissions of a major facility that equal or exceed significant emission rates as defined in IDAPA 58.01.01.006.92
- Cause a violation of the ambient air quality standard (i.e., National Ambient Air Quality Standards) for criteria air pollutants
- Exceed screening-emission levels or acceptable ambient concentrations listed in IDAPA 58.01.01.585 and 58.01.01.586 for noncarcinogenic and carcinogenic TAPs, respectively.

2.4 Emissions During Drum Storage

Waste excavated from Pit 4 will be placed in drums and transported to a CERCLA storage area. Small emissions of VOCs are possible during this storage phase, even though waste will be contained inside sealed polyethylene bags, inside vented drums. Previous analysis of maximum potential emissions during drum storage was performed for the Stage II Project (Abbott 2000) and in the *Potential Air Emissions from the OU 7-10 Stage II CERCLA Storage Facility* (Abbott 1999). The latter included a 1996 evaluation of emissions from the Waste Storage Facility at RWMC, based on storage of 70,000 drum equivalents of mixed TRU waste. Air modeling performed for that project showed maximum air concentrations of CCl_4 to be 43% of the allowable TAP increment ($6.7\text{E-}02 \mu\text{g}/\text{m}^3$) (IDAPA 16.01.01.586). For the three reasons listed below, storage emissions from the present project are expected to be far less than in the 1996 study and are not evaluated further in this EDF:

1. Number of drums anticipated to be generated by ARP is 12,500, or 18% of the 70,000 drums cited above.
2. Carbon tetrachloride concentration in the described area waste is expected to be much less than for waste in the 1996 evaluation.
3. In the present analysis, all CCl_4 in waste is assumed released during excavation and handling of waste. This is a bounding assumption, the effect of which is far greater than any small leakage that might occur during drum storage.

3. DOSE ASSESSMENT AND AIR-DISPERSION MODELING

3.1 Radionuclides

3.1.1 Model

The CAP-88 dose assessment code (EPA 1990) was used with the NESHAP default parameters to determine the maximum effective dose equivalent (EDE) (in mrem/year) from radionuclide emissions during the operational period. A workstation version of the mainframe CAP-88 model traditionally has been used at the Idaho Completion Project for NESHAP compliance and State of Idaho air permitting.

3.1.2 Source Parameter Input

Emissions were modeled as a ground-level point source to conservatively bound the downwind receptor impacts for any stack or vent design. That is, any elevated stack release would result in lower downwind air concentrations at ground level than those calculated in this EDF. In addition, if the release point is through a roof vent or short stack, the plume would be initially diluted by building wake effects that also would reduce near-field concentrations compared to those calculated using the point source assumptions in this assessment.

3.1.3 Meteorological Input File

The input file was a 10-year joint frequency "STAR" file (CFA.STR) developed from the 1987-to-1996, 15-m-high Central Facilities Area (CFA) meteorological tower data (CFA.10Y) by the National Oceanic and Atmospheric Administration (NOAA) office in Idaho Falls, Idaho. Wind data from CFA were used because a reliable long-term data set does not yet exist for the RWMC. The NOAA data incorporate calm hours into the lowest wind-speed class.

3.1.4 Receptor Locations

The two receptor locations evaluated are described below:

1. **Maximum exposed individual:** This is the location of the maximum annual INEEL air concentration (and dose) resulting in the highest EDE to any member of the public at any off-Site point where there is a residence, school, business, or office. This location, identified as Frenchman's Cabin, is approximately 7,976 m south-southwest of the RWMC. The dose calculated at this location is based on continuous exposure to inhalation, ground deposition, immersion, and ingestion of contaminated food. The model output files for these runs are "rwm1.cap" and "rwm2.cap." (Note: This file is maintained by the author.)
2. **Maximum worker:** This is the location of maximum air concentration in any direction at a worst-case (minimum for modeling purposes) dispersion distance of 100 m. This location is meant to represent a reasonable worst-case-exposure location for all workers because it assumes an individual worker remains at that exact location continuously for the entire work year (2,000 hours). Closer distances are not assessed because (a) of the high uncertainty of the dispersion model at distances less than 100 m, (b) the model point source algorithm would produce unrealistically high air concentrations, and (c) exact worker locations and residence times relative to the wind directions are impossible to predict. Worker doses do not include the ingestion pathway because no food products are grown at the work location. The model output files for these runs are "rwmW1.cap" and "rwmW2.cap." (Note: This file is maintained by the author.)

3.2 Nonradiological Contaminants

The refined air quality model, Industrial Source Complex Short Term (ISCST) 3 (EPA Version 02035) was run with 5-year average meteorological data from the 10-m level of the Grid 3 tower. A unit (1 g/second) release rate was used to obtain output in $\mu\text{g}/\text{m}^3$ per g/second for any contaminant released with an appropriate averaging time. These unit release concentrations can be multiplied by a criteria or TAP emission rate (g/second) to obtain the maximum increase (or increment) in ambient air concentration ($\mu\text{g}/\text{m}^3$) for a specific source. Calculated results can then be compared to criteria and TAP increment levels published in IDAPA 58.01.01.577 and .585 and .586, respectively.

3.2.1 Meteorological Data

Meteorological data used include the following:

- Five years (1997 to 2001) of sequential hourly surface data from the 10-m level of the Grid 3 meteorological tower (13 km northeast of the RWMC), processed by NOAA. This dataset was selected because of known problems with the RWMC meteorological data and other problems discovered with the CFA (next closest facility) meteorological data.
- Mixing heights were manually entered in the meteorological file in accordance with INEEL protocol (i.e., 150 m for short-term modeling and 800 m for annual modeling).

3.2.2 Receptor Input

- **Public impacts:** Discrete receptors were placed along U.S. Highway 20/26, EBR-I and EBR-I access road, and the southern INEEL boundary. Receptors were placed at 100-m intervals in locations of maximum impact (in the general downwind directions of the RWMC). Receptor elevations were taken from the INEEL Geographical Information System database.
- **Radioactive Waste Management Complex worker impacts:** The ISCST3 modeling run evaluated a polar receptor grid with 10-degree radials and distance intervals of 100 m from the source. Receptor elevations were set to the source elevation (i.e., 1,528 m).

3.2.3 ISCST3 Modeling Results

ISCST3 air-dispersion modeling for the ARP included pollutant releases as a ground-level release to the maximum exposed RWMC worker located 100 m from the release point, to the nearest point of public access (EBR-I), and to the nearest INEEL boundary. The gram-per-second emission rate was also modeled as an elevated release from a 20-ft stack to the maximum exposed RWMC worker.^c The results of ISCST3 air-dispersion modeling are presented in Table 3.

c. M. L. Abbott E-mail to Chris Staley, May 19, 2004, "New Modeling Results," ISCST3 (EPA vs. 02035), INEEL.

Table 3. ISCST3^a modeling results.

Release Height (ft)	Receptor Location (m)	Unit Release Concentration ($\mu\text{g}/\text{m}^3$ per g/second) per Averaging Time				
		1 hour	3 hours	8 hours	24 hours	Annual
Ground level (0)	100	33,686	—	11,125	—	261
Stack release (20)	250	122	—	99	—	10.4
Ground level (0)	EBR-I (2,900)	108	36	20	9.4	0.37
Ground level (0)	INEEL boundary (5,900)	—	—	—	—	0.23

a. EPA Version 02035.

EBR = Experimental Breeder Reactor

EPA = U.S. Environmental Protection

INEEL = Idaho National Engineering and Environmental Laboratory

In documenting compliance with IDAPA 58.01.01.577 ambient air quality standards for criteria air pollutants, maximum emission rates are modeled as a ground-level release to the nearest public receptor (i.e., EBR-I) using the appropriate pollutant averaging time. To determine compliance with IDAPA 58.01.01.585 noncarcinogenic TAPs, maximum emission rates are modeled as a ground-level release to the nearest public receptor using a 24-hour pollutant averaging time. To demonstrate compliance with IDAPA 58.01.01.586 carcinogenic TAPs, maximum or annualized emission rates are modeled as a ground-level release to the nearest INEEL boundary using an annual averaging time. To demonstrate compliance with the occupational exposure limit for CCl_4 , pollutant emissions were modeled as both a ground-level release and as a stack release to the maximum exposed RWMC worker.

4. SHORT-TERM RISK FOR CARBON TETRACHLORIDE

The carcinogenic risk from CCl₄ short-term exposure was evaluated for the maximum worker and public access (EBR-I) impact locations. The short-term risks were calculated using the State of Idaho acceptable ambient concentration for carcinogens (AACC) (μg/m³ per 1E-06 risk) for CCl₄, which assumes 70 years (25,550 days) of exposure. This AACC was developed from EPA unit risk factors, which are risk per μg/m³ assuming 70 years of chronic exposure. The risk factor for 1 year of exposure to modeled air concentration at each receptor (C_r) was calculated using the following equation:

$$Risk = \left(\frac{C_r (1E-06 \text{ risk})}{AACC} \right) \left(\frac{T_E}{25,550 \text{ days}} \right) \quad (1)$$

where

C_r = Receptor annual average air concentration (μg/m³)

AACC = Acceptable ambient concentration for carcinogens for CCl₄ (μg/m³ per 1E-06 risk)

T_E = Short-term scenario exposure time (days).

For both workers and the public at EBR-I, T_E was assumed to be 200 days (i.e., 4 days per week, 50 weeks per year).

5. RESULTS

5.1 Radionuclide Emissions

5.1.1 Effective Dose Equivalent To Members of the Public

Provisions of 40 CFR 61, Subpart H, "National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities," apply to operations at any facility owned or operated by DOE that emit any radionuclide other than Ra-222 and Ra-220 into the air. In accordance with 40 CFR 61.92, "Standard," emissions of radionuclides to the ambient air from DOE facilities shall not exceed amounts that would cause any member of the public to receive, in any year, an EDE of 10 mrem/year. To determine compliance with the standard, radionuclide emissions must be determined and EDE values to members of the public calculated using EPA-approved sampling procedures, computer models CAP-88 or AIRDOS-PC, or other procedures for which EPA has granted prior approval.

The EDF-4428 estimated radionuclide emissions from excavation and handling. Though most emissions are expected to be exhausted through a HEPA-filtered ventilation system before discharge to the atmosphere, a small fraction (0.5%, or $5\text{E-}03$ [EDF-4825]) could escape the enclosure without HEPA filtration; thus, the original radionuclide emission estimate was multiplied by a factor of ($5\text{E-}03 + 3\text{E-}04 = 5.3\text{E-}03$) to account for, respectively, leakage and effluent mitigation by a single HEPA filter rated at 99.97% efficiency for particulate removal. The resulting mitigated source term value was subsequently modeled using CAP-88 to determine the EDE value to the INEEL MEI. As presented in Table 4, the abated EDE to the INEEL MEI is estimated at $2.7\text{E-}02$ mrem/year, which is a factor of 370 lower than the 40 CFR 61.92 standard of 10 mrem/year.

Since the 40 CFR 61.92 standard of 10 mrem/year applies to calendar-year emissions from the entire INEEL Site, the projected abated release from the ARP must be combined with all other INEEL radionuclide emission sources to demonstrate compliance with the federal standard. A review of the EDE to the MEI due to operations from the INEEL from calendar years 1994 through 2002 (DOE-ID 1995, 1996, 1997, 1998, 1999, 2000, 2001) has indicated an average INEEL EDE of $2.5\text{E-}02$ mrem/year, which is only 0.25% of the standard. Considering the addition of potential abated radionuclide emissions from the ARP to the average INEEL EDE, the resulting INEEL Site-wide emission projection could increase to $5.2\text{E-}02$ mrem/year, or 0.52% of the 40 CFR 61.92 standard. Thus, the contribution of abated emissions from the proposed project, while increasing the total INEEL dose, is anticipated to have no impact on the ability of the INEEL to document compliance with the 10-mrem/year-dose standard.

5.1.2 Radionuclide Monitoring Requirements

It is necessary to evaluate the potential for radionuclide emissions for the release point to determine whether a release point is subject to the emission measurement requirements of 40 CFR 61.93.b (continuous monitoring). To evaluate the potential of a point source to discharge radionuclides into the air (for purposes of continuous monitoring), estimated radionuclide release rates are based on the effluent stream discharge that would result if no pollution control equipment existed but other facility operations remained normal. Sources with unmitigated potential emissions determined to equal or exceed 0.1 mrem/year are required to be continuously monitored.

ENGINEERING DESIGN FILE

Table 4. Radionuclide emissions and dose consequence analysis for the Accelerated Retrieval Project.

Radionuclide	Ground Level Release Rate		MEI EDE		Worker EDE (mrem/year)	Worker EDE (mrem/year)	Ground Level Release Rate			MEI EDE		Worker EDE (mrem/year)
	Unabated (Ci/year)	Abated (Ci/year)	Unabated (mrem/year)	Abated (mrem/year)			Unabated (Ci/year)	Abated (Ci/year)	Unabated (mrem/year)	Abated (mrem/year)		
Ac-225	1.12E-07	5.96E-10	2.07E-08	1.10E-10	8.01E-08		Pu-238	8.23E-03	4.36E-05	8.39E-02	4.45E-04	3.04E-01
Ac-227	1.87E-10	9.92E-13	3.69E-09	1.95E-11	1.39E-08		Pu-239	2.59E-01	1.37E-03	2.85E+00	1.51E-02	1.02E+01
At-217	1.12E-07	5.96E-10			1.29E-150		Pu-240	5.79E-02	3.07E-04	6.37E-01	3.37E-03	2.30E+00
Am-241 ^a	8.18E-02	4.34E-04	1.38E+00	7.33E-03	5.14E+00		Pu-241	2.91E-01	1.54E-03	5.00E-02	2.65E-04	1.74E-01
Bi-210	6.04E-12	3.20E-14	3.50E-14	1.86E-16	1.38E-13		Pu-242	5.42E-06	2.87E-08	5.64E-05	2.99E-07	2.04E-04
Bi-211	1.86E-10	9.87E-13	6.56E-19	3.47E-21	1.86E-14		Ra-223	1.86E-10	9.87E-13	5.29E-11	2.80E-13	7.46E-11
Bi-212	5.75E-16	3.05E-18	2.75E-19	1.46E-21	2.28E-18		Ra-225	1.13E-07	5.97E-10	1.91E-08	1.01E-10	2.28E-08
Bi-213	1.12E-07	5.96E-10	1.73E-12	9.17E-15	1.71E-11		Ra-226	2.00E-11	1.06E-13	1.23E-11	6.53E-14	8.64E-12
Bi-214	2.00E-11	1.06E-13	1.27E-15	6.72E-18	2.79E-14		Rn-219	4.51E-05	4.51E-05	3.39E-110	3.39E-110	5.89E-13
C-14	7.87E-05	7.87E-05	1.62E-07	1.62E-07	2.17E-08		Rn-220	1.42E-10	1.42E-10	1.77E-21	1.77E-21	2.18E-17
Co-60	3.06E-09	1.62E-11	6.05E-10	3.21E-12	1.51E-09		Rn-222	4.93E-06	4.93E-06	—	—	—
Cs-137	3.06E-06	1.62E-08	6.17E-07	3.27E-09	1.28E-06		Sr-90	2.39E-05	1.27E-07	3.29E-06	1.74E-08	2.66E-07
Ba-137m	2.91E-06	1.54E-08	—	—	—		Y-90	2.39E-05	1.27E-07	—	—	—
Fe-55	3.44E-08	1.82E-10	1.49E-11	7.88E-14	6.20E-12		Tc-99	8.33E-10	4.41E-12	2.35E-11	1.25E-13	3.35E-13
Fr-221	1.12E-07	5.96E-10	1.08E-13	5.73E-16	5.19E-11		Th-227	1.84E-10	9.75E-13	6.38E-11	3.38E-13	1.04E-10
Fr-223	2.58E-12	1.37E-14	4.03E-17	2.14E-19	8.13E-16		Th-229	1.13E-07	5.99E-10	2.35E-06	1.25E-08	3.84E-06
H-3	8.75E-04	8.75E-04	3.26E-08	3.26E-08	2.50E-06		Th-230	2.45E-09	1.30E-11	1.82E-08	9.67E-11	2.97E-08
I-129	2.58E-08	2.58E-08	1.14E-08	1.14E-08	1.69E-06		Th-231	6.34E-07	3.36E-09	1.83E-11	9.68E-14	3.06E-11
Ni-59	5.49E-09	2.91E-11	2.03E-12	1.08E-14	3.68E-12		Th-232	8.09E-16	4.29E-18	1.46E-14	7.75E-17	2.33E-14
Ni-63	1.91E-04	1.01E-06	7.72E-08	4.09E-10	5.04E-08		Ac-228	—	—	—	—	—
Np-237	5.83E-07	3.09E-09	8.94E-06	4.74E-08	3.32E-05		Ra-224	—	—	—	—	—
Pa-231	4.62E-10	2.45E-12	7.07E-09	3.75E-11	2.59E-08		Ra-228	—	—	—	—	—
Pa-233	5.80E-07	3.07E-09	5.98E-10	3.17E-12	1.11E-09		Th-228	—	—	—	—	—
Pb-209	1.12E-07	5.96E-10	2.59E-13	1.37E-15	1.33E-12		Tl-207	1.86E-10	9.84E-13	3.84E-19	2.04E-21	7.20E-17
Pb-210	6.05E-12	3.21E-14	1.04E-11	5.53E-14	5.73E-12		Tl-208	2.07E-16	1.10E-18	1.49E-23	7.90E-26	1.44E-20
Pb-211	1.86E-10	9.87E-13	1.69E-14	8.97E-17	2.06E-13		Tl-209	2.43E-09	1.29E-11	1.31E-17	6.92E-20	8.60E-14
Pb-212	5.75E-16	3.05E-18	2.64E-18	1.40E-20	1.14E-17		U-233	6.30E-05	3.34E-07	2.66E-04	1.41E-06	4.08E-04
Pb-214	2.00E-11	1.06E-13	1.24E-15	6.58E-18	2.00E-14		U-234	7.61E-06	4.04E-08	3.16E-05	1.67E-07	4.82E-05
Po-210	6.05E-12	3.20E-14	4.06E-12	2.15E-14	6.10E-12		U-235	6.34E-07	3.36E-09	2.49E-06	1.32E-08	3.78E-06
Po-211	5.08E-13	2.69E-15	—	—	—		U-236	4.46E-07	2.37E-09	1.75E-06	9.26E-09	2.68E-06
Po-212	3.69E-16	1.95E-18	—	—	—		U-237	7.13E-06	3.78E-08	1.69E-09	8.94E-12	1.70E-09
Po-213	1.10E-07	5.83E-10	—	—	—		U-238	3.70E-05	1.96E-07	1.37E-04	7.28E-07	2.09E-04
Po-214	2.00E-11	1.06E-13	—	—	—		Th-234	3.70E-05	1.96E-07	—	—	—
Po-215	1.86E-10	9.87E-13	—	—	—		Pa-234	5.92E-08	3.14E-10	—	—	—
Po-216	5.75E-16	3.05E-18	—	—	—		Pa-234m	3.70E-05	1.96E-07	—	—	—
Po-218	2.00E-11	1.06E-13	1.77E-18	9.37E-21	5.82E-15		Effective Dose Equivalent			5.00E+00	2.65E-02	1.82E+01

^a Total Am-241 equals the sum total of original Am-241 and the Am-241 resulting from beta decay of Pu-241.

Note: Po-211 through Po-216 are not included as isotopes within the CAP-88 modeling program. Additionally, for purposes of dose consequence, At-217 is a radon decay product in the U-238 decay chain, is short lived, and, therefore, not expected to result in dose to a long distance receptor such as the MEI located at Frenchman's Cabin (i.e., location 7.976 m south-southwest of the RWMC).

EDE = effective dose equivalent MEI = maximum exposed individual RMC = Radioactive Waste Management Complex

The radionuclide source term associated with the retrieval area was calculated as a function of the percentage of exposed MAR, and various airborne release factors (EDF-4428; EDF-4591). Continuous monitoring analysis requires that emissions be estimated without consideration of mitigation by control equipment (i.e., HEPA filters).

The unabated EDE to the INEEL MEI is 5.0 mrem/year, a value 50 times greater than the 0.1 mrem/year threshold limit for continuous monitoring. Thus the requirement for continuous monitoring is applicable to the ARP.

In accordance with 40 CFR 61.93, "Emission Monitoring and Test Procedures," all radionuclides that could contribute more than 10% of the potential EDE for a release point are required to be measured. Accordingly, Table 5 identifies Am-241, Pu-239, and Pu-240 as those radionuclides requiring continuous monitoring or sampling.

Table 5. Radionuclides requiring continuous monitoring.

Radionuclide	Unabated Ground Level Release (Ci/year)	Maximum Exposed Individual Unit Curie Dose (mrem/year)	Unabated Effective Dose Equivalent (mrem/year)	Cumulative Fraction of Maximum Exposed Individual Total Dose	Percentage Contribution to Maximum Exposed Individual Total Dose
Pu-239	2.59E-01	1.10E+01	2.85E+00	0.5693	56.7
Am-241	8.18E-02	1.69E+01	1.38E+00	0.8458	27.7
Pu-240	5.79E-02	1.10E+01	6.37E-01	0.9731	12.7
Pu-238	8.23E-03	1.02E+01	8.39E-02	0.9899	1.7%
Pu-241	2.91E-01	1.72E-01	5.00E-02	0.9999	1.0%
U-233	6.30E-05	4.23E+00	2.66E-04	1.0000	0.005%

5.1.3 Effective Dose Equivalent to the Radioactive Waste Management Complex Worker

The EDE to the RWMC worker was calculated using the abated radionuclide emission rate and resulting unit curie dose factors to the RWMC worker assumed to be continuously located 100 m from the point source for the entire work year (2,000 hours). As calculated in Table 4, the abated EDE to the RWMC worker is 1.82E+01 mrem/year, which is a fraction (2.6 and 0.4%, respectively) of the INEEL administrative exposure control level, from the Manual 15A, of 700 mrem/year and the 10 CFR 835 exposure control level of 5,000 mrem/year.

5.2 Nonradiological Emissions

5.2.1 Nonvolatile Contaminants

Distribution of contaminants potentially present within the retrieval area is not well defined; thus, abated particulate emission values from Table 2 are used as an estimate of nonvolatile contaminants. The calculated abated emission rates and resulting ambient concentrations were compared to the IDAPA 58.01.01.585 and .586 screening-emission levels and acceptable ambient concentrations, assuming that the entire particulate emission is representative of a specific IDAPA TAP for which a comparison is being made.

Relative to IDAPA 58.01.01.585 noncarcinogenic TAPs, the point of compliance is the receptor site estimated to have the highest ambient concentration of TAP of all receptor sites located either at or

beyond the facility property boundary or at a point of public access. Additionally, the IDAPA acceptable ambient concentration for noncarcinogens is based on 24-hour averages. Thus, in determining the potential for ambient concentrations for noncarcinogens, the unit release concentration with a 24-hour average and a receptor location of EBR-I from Table 3 (i.e., $9.429 \mu\text{g}/\text{m}^3$ per g/second) was used.

Relative to IDAPA 58.01.01.586 carcinogenic TAPs, the receptor site is not considered to be at a point of public access if the receptor site is located on or within a road, highway, or other transportation corridor transecting the facility. The carcinogenic TAP receptor site is estimated to occur at the INEEL boundary nearest to RWMC having the highest ambient concentration. Additionally, the IDAPA acceptable ambient concentration for carcinogens is based on annual averages. Thus, in determining the potential for ambient concentrations for carcinogens, the unit-release concentration—with an annual average and a receptor location approximately 5,900 m from RWMC, from Table 3 (i.e., $0.23 \mu\text{g}/\text{m}^3$ per g/second)—was used.

The abated particulate emission values from Table 2, with their corresponding ambient concentrations, are presented in Table 6.

Table 6. Nonvolatile contaminant emission rate and resulting ambient concentration.

Pollutant	Hourly Abated Emission Rate (lb/hour)	Ambient Impact ^a (as noncarcinogenic toxic air pollutant) (mg/m^3)	Annual Abated Emission Rate (ton/year)	Ambient Impact ^b (as a carcinogenic toxic air pollutant) ($\mu\text{g}/\text{m}^3$)
Particulate matter (as a nonvolatile contaminant)	2.90E-03	3.4E-06	1.45E-03	9.7E-06

a. Ambient impact as an IDAPA noncarcinogenic TAP is calculated as
[hourly emission rate (lb/hour)] \times [0.126 g/second per lb/hour] \times [unit release concentration ($9.4 \mu\text{g}/\text{m}^3$ per g/second)] \times [1 mg/1E+03 μg].

b. Ambient impact as an IDAPA carcinogenic TAP is calculated as
[annual emission rate (ton/year)] \times [0.029 g/second per ton/year] \times [unit release concentration ($0.23 \mu\text{g}/\text{m}^3$ per g/second)].

IDAPA = Idaho Administrative Procedures Act
TAP = toxic air pollutant

Based on a comparison of the projected ambient concentration of $9.7\text{E}-06 \mu\text{g}/\text{m}^3$ (from Table 6) to acceptable ambient concentration levels for all carcinogenic TAPs listed in IDAPA 58.01.01.586, five carcinogens have acceptable ambient concentrations lower than the ambient concentration projected for the ARP:

- Asbestos
- 1, 3 Dichloropropene
- Diethylstilbestrol
- N-nitroso-N-methylurea
- 2,3,7,8-Tetrachlorodibenzo-p-dioxin.

These constituents are not expected to be present in Pit 4 waste.

5.2.2 Volatile Organic Contaminants

Carbon tetrachloride is the VOC present in the greatest abundance in the retrieval area; it also possesses a fairly restrictive emission concentration limit. According to Table 5-4, "Composition of the organic setups expected in Area G," of the Conceptual Design Report (Austad 2004), CCl₄ accounts for approximately 40% of the organic setups expected in the retrieval area, followed by tetrachloroethylene at 11%, trichloroethylene at 10%, and trichloroethane at 9%. In addition, these other three organics have health-based air concentration limits similar to or higher than CCl₄. Based on these factors, a demonstration of compliance for CCl₄ with the IDAPA 58.01.01.586 acceptable ambient concentration limit will serve as a demonstration of compliance for all other volatile TAPs potentially present within the retrieval area.

Table 7. Demonstration of compliance with uncontrolled ambient concentration limits for carbon tetrachloride.

Pollutant	Annual Emission Rate ^a (g/second)	IDAPA 58.01.01.586 Emission Screening Level (g/second)	Annual Unit Release Concentration (µg/m ³ per g/second)	Potential Ambient ^b Impact (µg/m ³)	IDAPA 58.01.01.586 Acceptable Ambient Concentration (µg/m ³)
CCl ₄	1.95	5.55E-05	0.23	4.5E-01	6.7E-01 ^b

a. Potential ambient impact for CCl₄ is calculated as
[annual emission rate (g/second)] × [annual unit release concentration (µg/m³ per g/second)].

b. This is short-term AACC (see explanation in body text below).

AACC = acceptable ambient concentration for carcinogens (CCl₄)

The actual acceptable ambient concentration listed in IDAPA 58.01.01.586 is 6.7E-02 µg/m³; however, in accordance with IDAPA 58.01.01.210.15, a short-term adjustment factor may be used for carcinogenic TAPs whereby the acceptable ambient concentration is multiplied by a short-term adjustment factor of 10. The IDAPA 58.01.01.007.11 defines a short-term source as any new stationary source, or modification to an existing source, with an operational life no greater than 5 years from inception of any operations to cessation of actual operations. The proposed project meets the IDAPA definition of a short-term source; therefore, the IDAPA 58.01.01.586 acceptable ambient concentration is adjusted from 6.7E-02 to 6.7E-01 µg/m³. As demonstrated in Table 7, the potential ambient impact from a release of CCl₄ from the ARP is less than the IDAPA adjusted acceptable ambient concentration for CCl₄.

5.2.2.1 Short-term Exposure Risk to the Public and the Radioactive Waste

Management Complex Worker. The carcinogenic risk from CCl₄ short-term exposure was evaluated for the RWMC worker and public access (EBR-I) impact locations. Calculation of risk, as previously discussed in Section 4, is presented in Table 8.

In interpreting estimates of cancer risk, the EPA under CERCLA generally considers action to be warranted when risks exceed a target risk level of 1E-04. As demonstrated in Table 8, cancer incidence is estimated at less than 1E-04 both for members of the public and the RWMC worker.

Table 8. Short-term exposure risk to the public and the Radioactive Waste Management Complex worker for carbon tetrachloride.

Receptor	Annual Emission Rate (g/second)	Unit Release Concentration ($\mu\text{g}/\text{m}^3$ per g/second)	Ambient Impact ($\mu\text{g}/\text{m}^3$)	Ratio Risk/AACC (risk per $\mu\text{g}/\text{m}^3$)	Exposure Ratio ^a	Short-term ^b Exposure Carcinogenic Risk
Public	1.95	0.37	7.92E-01	1.49E-06	7.83E-03	9.24E-09
Worker	1.95	261	5.59E+02	1.49E-06	7.83E-03	6.52E-06

a. Exposure ratio is the ratio of exposure time (200 days for this project) to the 70 years (25,550 days) used by EPA for developing carcinogenic risks (see Section 4).

b. Short-term risk is calculated as [Ambient impact ($\mu\text{g}/\text{m}^3$)] \times [ratio risk/AACC (risk per $\mu\text{g}/\text{m}^3$)] \times [exposure ratio].

AACC = acceptable ambient concentration for carcinogens (CCl_4)

EPA = U.S. Environmental Protection Agency

5.2.2.2 Occupational Exposure. The occupational exposure risk to the RWMC worker is based on a short-term emission rate of 2.05 g/second and the resulting ambient concentration based on an 8-hour averaging period. Potential ambient concentrations of CCl_4 were originally addressed as a ground-level release with a receptor height of zero, a receptor distance of 100 m from the emission source, and without building downwash effects. This type of modeling scenario provides a conservative estimate of ambient concentrations; however, relative to CCl_4 releases from the ARP, resulted in ambient concentrations close to the Occupational Safety and Health Act (29 CFR 1910) occupation exposure limit. Thus, a second analysis was performed by modeling emissions as though released from a 20-ft stack at a nominal flow rate of 20,000 ft^3 per minute. The second analysis demonstrated compliance with the occupational exposure limit by a much wider margin (see Table 9).

Table 9. Occupational exposure of the Radioactive Waste Management Complex worker to carbon tetrachloride.

Pollutant	Short-term Emission Rate (g/second)	Unit Release Concentration, 8-hour (ground-level) ($\mu\text{g}/\text{m}^3$ per g/second)	Ambient ^a Concentration ($\mu\text{g}/\text{m}^3$)	Unit Release Concentration, 8-hour (20-ft stack) ($\mu\text{g}/\text{m}^3$ per g/second)	Ambient ^a Concentration ($\mu\text{g}/\text{m}^3$)	Occupational Exposure Limit ($\mu\text{g}/\text{m}^3$)
Carbon tetrachloride	2.05	11,125	2.3E+04	99	2.0E+02	3.10E+04

a. Ambient concentration is calculated as [short term emission (g/second)] \times [unit release concentration, 8 hours].

5.2.3 Diesel Exhaust Emissions

Emission calculations for diesel-fired fuel-burning equipment are based on the assumption that both Gradall EX-5200 excavators (each rated at 175 hp) and the Tele-Handler TH-103 all terrain forklift with a peak horsepower rating of 105 are used simultaneously; thus, a total horsepower rating of 455 is used for all emission calculations. As identified in Table 10, based on an operational limitation of 5,660 hours per year, potential emissions will be less than IDAPA 58.01.01.006.92 significant emission limits. Thus, the requirement to install and operate best available control technology is not applicable so long as the operational limitation of 5,660 hours per year is not exceeded.

Table 10. Criteria air pollutant analysis for fuel-burning equipment.

Pollutant	Emission Factor ^a (lb/hp-hour)	Hourly Potential Emissions ^b (lb/hour)	Annual Potential Emissions ^c (ton/year)	IDAPA 58.01.01.006.92 Significant Emission Limit (ton/year)
NO _x	3.10E-02	1.41E+01	39.9	40
CO	6.68E-03	3.04E+00	8.7	100
SO _x	2.05E-03	9.33E-01	2.6	40
PM-10	2.20E-03	1.00E+00	2.8	15
Total organic carbon (as ozone)	2.51E-03	1.14E+00	3.2	40

a. Emission factors obtained from EPA (1998); Chapter 3, "Stationary Internal Combustion Engines"; Section 3.3, "Gasoline and Diesel Industrial Engines (Final Section, Supplement B, October 1996)"; Table 3.3-1.

b. Hourly potential emissions calculated as [emission factor (lb/hp-hour)] × [455 hp].

c. Annual potential emissions calculated as [emission factor (lb/hp-hour)] × [455 hp] × [5,660 hours/year] × [1 ton/2,000 lb].

Based on the criteria pollutants potentially emitted from diesel fuel combustion, a demonstration of compliance with IDAPA 58.01.01.577 is required. Accordingly, the criteria air pollutant emission rates were modeled, uncontrolled, as a ground-level release to the nearest public receptor (i.e., EBR-I). The results of ambient impact modeling are presented in Table 11.

The emission profile associated with diesel combustion also includes several pollutants identified as IDAPA TAPs. In accordance with IDAPA 58.01.01.161, any contaminant that, by its nature, is toxic to human or animal life or vegetation shall not be emitted in such quantities or concentrations as to alone, or in combination with other contaminants, injure or unreasonably affect human or animal life or vegetation. To demonstrate compliance with IDAPA 58.01.01.161, potential TAP emissions from fuel-burning equipment are compared against the State of Idaho screening-emission levels and acceptable ambient concentration limits for noncarcinogenic TAPs referenced in IDAPA 58.01.01.585 and carcinogenic TAPs referenced in IDAPA 58.01.01.586.

Considering simultaneous operation of all fuel-burning equipment within the enclosure, a maximum pound-per-hour emission rate can be calculated and, if necessary, modeled to determine ambient concentrations. A demonstration of compliance with the TAP emissions from fuel-burning equipment is present in Table 12. As a first-order level of screening, the maximum pound-per-hour emission rate is compared against the IDAPA 58.01.01.585/.586 screening-emission levels. Those pollutants with emission rates exceeding the IDAPA screening-emission levels were subsequently modeled to determine maximum ambient impacts and compared to the IDAPA acceptable ambient concentration limit.

Table 11. Criteria air pollutant ambient concentration analysis for fuel-burning equipment.

						IDAPA 58.01.01.577 Ambient Air Quality Standard (µg/m³)
Pollutant/ Averaging Time	Emission Rate ^a (g/second)	Unit Release Concentration (µg/m³ per g/second)	Source ^b Contribution (µg/m³)	INEEL Background Concentration (µg/m³)	Total Ambient ^d Impact (µg/m³)	
NO ₂ /annual	1.78E-01	0.37	6.59E-02	2.7 ^c	2.8	100
CO/1 hour	3.83E-01	108	4.14E+01	11,450	11,491	40,000
CO/8 hours	3.83E-01	20	7.66E+00	5,130	5,138	10,000
SO ₂ /3 hours	1.18E-01	36	4.25E+00	374	378	1,300
SO ₂ /24 hours	1.18E-01	9.4	1.11E+00	120	121	365
SO ₂ /annual	1.18E-01	0.37	3.54E-02	7.5 ^c	7.5	80
PM-10/ ^c 24 hours	1.26E-01	9.4	1.18E+00	86	87	150
PM-10/ annual	1.26E-01	0.37	4.66E-02	32.7	32.7	50
Ozone/ 1 hour	1.44E-01	108	1.56E+01	—	—	235

a. Emission rate is calculated as [Table 10 emission rate (lb/hour)] \times [0.126 g/second per lb/hour].

b. Source contribution is calculated as [emission rate (g/second)] \times [unit release concentration ($\mu\text{g}/\text{m}^3$ per g/second)].

c. INEEL background concentrations for NO₂ (reported as NO_x) and SO₂/annual from continuous monitoring on INEEL, reported in the INEEL annual environmental monitoring report, (DOE/ID-12082 [per year]); all other background data from Darrin Mehr, associate air quality engineer, IDEQ, November 8, 2001. Note: IDEQ does not have necessary data to develop a background concentration for the 1-hour ozone standard.

d. Total ambient impact is calculated as [source contribution ($\mu\text{g}/\text{m}^3$)] + [INEEL background concentration ($\mu\text{g}/\text{m}^3$)].

e. "All particulate matter in air with an aerodynamic diameter less than or equal to a nominal 10 microns..." (IDAPA 58.01.01 2003).

IDAPA = Idaho Administrative Procedures Act

IDEQ = Idaho Department of Environmental Quality

INEEL = Idaho National Engineering and Environmental Laboratory

Table 12. Toxic-air-pollutant analysis for fuel-burning equipment.

Pollutant	Emission ^a	Emission ^b	Potential ^c	IDAPA 58.01.01.585/ .586 Screening Emission Limit (lb/hour)	Potential ^d	IDAPA 58.01.01.585/.586 Acceptable Ambient Concentration (µg/m ³)
	Factor (lb/MM Btu)	Factor (lb/ hp-hour)	Emissions (lb/hour)		Ambient Impact (µg/m ³)	
Benzene	9.33E-04	6.53E-06	2.97E-03	8.00E-04	8.61E-05	1.20E-01
Toluene	4.09E-04	2.86E-06	1.30E-03	2.50E+01	—	—
Xylenes	2.85E-04	2.00E-06	9.08E-04	2.90E+01	—	—
1,3-Butadiene	3.91E-05	2.74E-07	1.25E-04	2.40E-05	3.62E-06	3.60E-03
Formaldehyde	1.18E-03	8.26E-06	3.76E-03	5.10E-04	1.09E-04	4.50E-01
Acetaldehyde	7.67E-04	5.37E-06	2.44E-03	3.00E-03	—	—
Acrolein	9.25E-05	6.48E-07	2.95E-04	1.70E-02	—	—
Polycyclic aromatic hydrocarbons	1.68E-04	1.18E-06	5.35E-04	9.10E-05	1.55E-05	1.40E-02

a. Emission factors obtained from EPA (1998); Chapter 3, “Stationary Internal Combustion Engines”; Section 3.3, “Gasoline and Diesel Industrial Engines (Final Section, Supplement B, October 1996)”; Table 3.3-2.

b. Emission factor (lb/hp-hour) was calculated using an average brake-specific horsepower rating of 7,000 Btu/hp-hour (EPA 1998, Table 3.3-1) to convert from lb/MM Btu (Note: MM Btu is million Btu) to hp-hour using the following equation:
[emission factor (lb/MMBtu)] × [1MMBtu/1E+06 Btu] × [7,000 Btu/hp-hour].

c. Potential to emit based on the maximum combined horsepower rating, considering simultaneous operation of both Gradall excavators and the Tele-Handler forklift (i.e., 455 hp). Potential to emit is calculated as follows: [emission factor (lb/hp-hour)] × [maximum combined horsepower rating (455 hp)].

d. Potential ambient impact is determined only for those pollutants with potential lb/hour emissions that exceed the IDAPA screening-emission limit and is calculated as follows: [potential to emit (lb/hour)] × [0.126 g/second per lb/hour] × [unit release concentration (µg/m³ per g/second)]. Note: all of the pollutants with potential lb/hour emissions exceeding their corresponding IDAPA screening-emission limit are identified as carcinogenic TAPs. The IDAPA acceptable ambient concentration for carcinogens is presented as an annual average; therefore, the unit release concentration for a ground-level release with an annual averaging time and a receptor located at the nearest INEEL boundary was used (i.e., 0.23 µg/m³ per g/second).

EPA = U.S. Environmental Protection Agency

IDAPA = Idaho Administrative Procedures Act

INEEL = Idaho National Engineering and Environmental Laboratory

TAP = toxic air pollutant

6. CONCLUSIONS

The potential exists to generate radiological, criteria, and TAPs during performance of the ARP. Excavation activities will occur within a weather enclosure with most (estimated at 99.5%) excavation and waste-handling emissions captured by the ventilation system and exhausted through a HEPA-filtered stack. The following conclusions may be drawn based on discussions presented within this EDF:

- The unabated EDE to the RWMC MEI located at Frenchman's Cabin is estimated at 5.0 mrem/year. The entire project is performed in a single calendar year and radionuclide emissions occur as a ground-level release, which results in a slightly lower dose consequence than radionuclide emissions released from a stack. However, because the proposed 20-ft stack does not meet EPA Good Engineering Practice (40 CFR 51.100, "Definitions") relative to the height of the Retrieval Enclosure Structure (i.e., the stack will not be 2.5 times the height of nearby structures), and CAP-88 does not model building downwash effects, the ground-level release model is appropriate for dose estimates. Because the unabated EDE exceeds 0.1 mrem/year, the requirement for continuous monitoring in accordance with 40 CFR 61, Subpart H, is applicable. Only those radionuclides that could contribute to more than 10% of the dose require continuous monitoring. As such, Am-241, Pu-239, and Pu-240 require continuous monitoring.
- The abated EDE to the INEEL MEI is estimated at $2.7\text{E-}02$ mrem/year, which is a factor of 370 lower than the 40 CFR 61.92 standard of 10 mrem/year. Additionally, considering the dose contribution from all other INEEL radiological sources, the addition of radionuclide emissions from the ARP is not anticipated to negatively impact the ability of INEEL to demonstrate compliance with EPA's emission limit of 10 mrem/year.
- The abated EDE to the RWMC worker is 18.2 mrem/year, which is a small fraction of the INEEL administrative control level of 700 mrem/year and the 10 CFR 835, exposure control level of 5,000 mrem/year.
- Particulate emissions, as a measure of nonvolatile contaminants, from ARP excavation activities are not expected to result in a release of any nonvolatile TAPs known to be in Pit 4 waste above IDAPA 58.01.01.585 and .586 emission limits.
- The volatile contaminant of concern has been identified as CCl_4 . This EDF assumes that a demonstration of compliance with emission limits for CCl_4 provides a demonstration of compliance with all other volatile contaminants potentially present in the retrieval area of Pit 4. The annual emission rate for CCl_4 of 1.95 g/second exceeds the IDAPA screening-emission level of $5.55\text{E-}05$ g/second; however, the modeled ambient concentration is projected at $4.5\text{E-}01$ $\mu\text{g}/\text{m}^3$, which is below the short-term (adjusted) IDAPA acceptable ambient concentration level of $6.7\text{E-}01$ $\mu\text{g}/\text{m}^3$. Carbon tetrachloride emissions were modeled as a ground-level release without consideration of potential building-downwash effects; therefore, CCl_4 modeling scenario results in a conservative estimate of downwind concentrations.
- Resulting cancer risks from CCl_4 releases to the public and the maximum exposed RWMC worker are estimated at $9.24\text{E-}09$ and $6.52\text{E-}06$, respectively. In interpreting estimates of cancer risk, the EPA, under CERCLA, generally considers action to be warranted when risks exceed a target risk level of $1\text{E-}04$.

- The resulting occupational exposure to the maximum exposed RWMC worker—based on a short-term CCl_4 release rate of 2.05 g/second and a ground-level release—is estimated at $2.3\text{E}+04 \mu\text{g}/\text{m}^3$. Modeled as an elevated release from a 20-ft stack, the resulting exposure concentration to the RWMC worker is estimated at $2.0\text{E}+02 \mu\text{g}/\text{m}^3$. Both of these concentrations are below the Occupational Safety and Health Act occupational exposure limit of $3.10\text{E}+04 \mu\text{g}/\text{m}^3$.
- Uncontrolled criteria air pollutant emissions from diesel-fired fuel-burning equipment will not occur in excess of IDAPA significance levels if operations adhere to a maximum, continuous, fuel-burning-equipment operational schedule of 5,660 hours per year or less.
- The resulting unabated ambient impact from criteria air pollutant emissions, considering simultaneous operation of all fuel-burning equipment, will not cause a violation of an Idaho or National Ambient Air Quality Standard.
- Potential uncontrolled TAP emissions from fuel-burning equipment will be less than IDAPA screening-emission levels or less than IDAPA acceptable ambient concentrations.

7. SUMMARY

Based on calculations documented in this EDF, emissions from the ARP will not result in violation of allowable emission rates or ambient air quality standards associated with federal Clean Air Act (42 USC § 7401 et seq., 1990) requirements or IDAPA, “Rules for the Control of Air Pollution in Idaho” (IDAPA 58.01.01); nor will the project result in any adverse health effects to workers outside the retrieval facility or to the public.

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Appendix A

Preliminary Estimate of Volatile Organic Compound Emissions during the Accelerated Retrieval Project for a Described Area of Pit 4

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Appendix A

Preliminary Estimate of Volatile Organic Compound Emissions during the Accelerated Retrieval Project for a Described Area of Pit 4

Eric C. Miller
June 2, 2004

A-1. OBJECTIVE

The purpose of this study is to estimate volatile organic compound (VOC) emissions that may result during excavation of the Accelerated Retrieval Project (ARP) retrieval area (see Figure 1 of main report) at the Radioactive Waste Management Complex (RWMC). Estimates of both long-term (1-year) and short-term (8-hour) VOC emission rates will be made to support the evaluation of compliance with acceptable ambient concentration for carcinogens (AACC) limits for a public receptor and with occupational exposure limits (OEL) for workers outside the Retrieval Enclosure. Estimates of long- and short-term emission rates are necessary to determine potential need for the following:

- An exhaust stack for the Retrieval Enclosure
- Off-gas treatment or capture (e.g., granular activated carbon)
- Exhaust stack or breathing air space monitoring outside the Retrieval Enclosure to ensure protection of the public and collocated workers.

A-2. METHODOLOGY

Although various VOCs are present within the retrieval area, carbon tetrachloride (CCl_4) is the VOC present in the greatest abundance (Miller and Varvel 2001), and is also the VOC with the most restrictive regulatory limits for both public and occupational receptors. Therefore, it is assumed that CCl_4 will be the VOC most likely to produce unacceptable emissions. This assumption is consistent with the findings of Engineering Design File (EDF) -2322, "Air Emissions Evaluation for the OU 7-10 Glovebox Excavator Method Project," which concluded that CCl_4 resulted in the highest impacts in all cases modeled. Therefore, this estimate will focus only on CCl_4 emissions during ARP excavation activities.

A-3. ESTIMATED LONG-TERM CARBON TETRACHLORIDE EMISSION RATE

A highly conservative, long-term estimate of the CCl_4 emission rate during excavation can be made by assuming that all CCl_4 in the described area will be released during the year assumed for excavation. This approach is highly conservative for the following reasons:

1. The mass of CCl_4 assumed to be present in the described area for the long-term estimate is based on the mass of CCl_4 originally buried in the Subsurface Disposal Area more than 30 years ago. Since burial, it is known that a significant mass of CCl_4 has migrated from the pits where it was originally buried.

2. It assumes that all mass from each drum would be entirely released during the excavation. Such complete losses are unlikely because excavated waste will likely be placed in waste boxes rapidly, which will reduce the time for volatilization to occur and preclude complete VOC loss.

Miller and Varvel (2001) report that approximately $8.2\text{E}+05$ kg of CCl_4 is contained within the 8,676 drums of Series 743 buried in the Subsurface Disposal Area. The EDF-4478 estimates that approximately 634 drums of Series 743 waste are contained within the described area. Equation (A1) calculates the total mass of CCl_4 within the described area:

$$634 \text{ drums} \times 8.2\text{E}+05 \text{ kg CCl}_4 / 8,676 \text{ drums} \times 1,000 \text{ g/kg} = 6.0\text{E}+07 \text{ g CCl}_4 . \quad (\text{A1})$$

Equation (A2) calculates the number of seconds in 1 year:

$$1 \text{ year} \times 365 \text{ days/year} \times 24 \text{ hours/day} \times 60 \text{ minutes/hour} \times 60 \text{ seconds/minute} = 3.2\text{E}+07 \text{ seconds} . \quad (\text{A2})$$

Dividing the results of Equation (A1) by the results of Equation (A2) produces the estimate of the long-term-emission rate of CCl_4 originating from the described area to be approximately 1.9 g/second.

This long-term emission rate does not include the contribution from air-phase migration from areas outside the described area. The described area within RWMC represents the extreme western extent of Series 743 waste in Pit 4, and the northern and southern boundaries of the described area within RWMC coincide with Pit 4 boundaries. As such, the western, northern, and southern margins of Pit 4 represent boundaries through which no significant mass of CCl_4 will likely enter the Retrieval Enclosure. Therefore, only air-phase migration through the eastern dig face will be considered. The mass of CCl_4 entering the Retrieval Enclosure through the eastern dig face will be governed by the rate of bulk airflow through the subsurface waste zone induced by the blower within the Retrieval Enclosure and the concentration of CCl_4 in the bulk air. The bulk airflow rate through the subsurface waste zone across the eastern boundary, induced by the Retrieval Enclosure blower, can be estimated using Equation (A3):

$$Q = K_i(\gamma/\mu)IA \quad (\text{A3})$$

where

Q = flow rate of fluid ($\text{length}^3/\text{time}$)

K_i = intrinsic permeability of the porous media (length^2)

γ = unit weight of fluid (air) = pg ($\text{mass}/\text{length}^2\text{-time}^2$)

μ = dynamic viscosity of fluid (air) ($\text{mass}/\text{length}\text{-time}$)

I = fluid pressure gradient ($\text{length}/\text{length}$)

A = cross-sectional area available for airflow (length^2)

given that

K_i	$= 5.7\text{E-}13 \text{ m}^2 \text{ (EDF-2376)}$
γ	$= 1.14\text{E}4 \text{ g/m}^2\text{second}^2$
μ	$= 1.86\text{E-}02 \text{ g/msecond}$
Pressure drop in the enclosure	$= 0.3 \text{ in. of water column (5.9 m of air)}$
Path over which this differential acts	$= 1.1 \text{ m (thickness of overburden through which make-up air would need to travel)}$
Cross-sectional area	$= 109 \text{ m}^2 (1,172 \text{ ft}^2).$

The bulk airflow rate can be calculated using Equation (A4):

$$Q = (5.7\text{E-}13 \text{ m}^2) \times (1.14\text{E}4 \text{ g/m}^2\text{second}^2 / 1.86\text{E-}02 \text{ g/msecond}) \times (5.9 \text{ m} / 1.1 \text{ m}) \times 109 \text{ m}^2$$

$$= 2.0\text{E-}04 \text{ m}^3/\text{second} . \quad (\text{A5})$$

Miller and Varvel (EDF-2376) estimated that the air-phase concentration of CCl_4 in equilibrium with original Series 743 waste was approximately 260 g/m^3 . Again, this value is highly conservative in assuming that no CCl_4 has been released since burial and that all subsurface soil gas is in equilibrium with an infinite mass of Series 743 waste. At a subsurface bulk airflow rate of $2.0\text{E-}04 \text{ m}^3/\text{second}$ and a CCl_4 air-phase concentration of 260 g/m^3 , the mass flow rate of CCl_4 across the eastern dig face is approximately 0.05 g/second ($2.0\text{E-}04 \text{ m}^3/\text{second} \times 260 \text{ g/m}^3$). When this value is added to the 1.9 g/second calculated for waste within the described area, the total is 1.95 g/second .

At a long-term CCl_4 emission rate of 1.95 g/second and a bulk airflow rate of $20,000 \text{ actual ft}^3/\text{minute (acfm)}$ from the Retrieval Enclosure Exhaust port, the CCl_4 concentration at the point of release (at 25°C) would be approximately 39 ppmv .

A-4. ESTIMATED SHORT-TERM CARBON TETRACHLORIDE EMISSIONS

A moderately conservative, short-term estimate of the CCl_4 emission rate during excavation can be made by assuming that a large percentage of any active dig face consists of Series 743 waste. Historical disposal records indicate that only the northern half of the described area within the RWMC contains Series 743 waste. Therefore, if it were assumed that 50% of any active dig face consisted of Series 743 waste, the CCl_4 release from the direct liquid-phase evaporation from Series 743 waste can be estimated. Miller (EDF-2376) reported that the CCl_4 flux rate from Series 743 series sludge is approximately $1.4\text{E-}03 \text{ g/ft}^2\text{second}$. As noted previously, the area of any given north-to-south-trending dig face within the described area is approximately $1,172 \text{ ft}^2$. Equation (A6) calculates the CCl_4 contribution from direct liquid-phase evaporation to the total short-term CCl_4 emission rate.

$$1.4\text{E-}03 \text{ g/ft}^2\text{second} \times (1,172 \text{ ft}^2 / 2) = 0.82 \text{ g/second} . \quad (\text{A6})$$

However, direct liquid-phase evaporation only accounts for a portion of the total CCl_4 released. Other transport mechanisms (e.g., vapor-phase diffusion and the lateral transport from blower-induced

advection) would add to the total CCl_4 release. Miller (EDF-2376) demonstrated that total CCl_4 emissions are not likely to be more than 2.5 times the direct liquid-phase evaporation rate. Using this relationship, the total CCl_4 short-term emission rate from all sources may be estimated as approximately 2.05 g/second (i.e., 0.82×2.5). It should be noted that various assumptions are embedded within the scaling factor of 2.5, the least defensible of which is the assumption that the path length over which diffusion will occur is 0.5 m (1.6 ft). Without a clear understanding of the actual distance from the changing dig face to the specific CCl_4 sources, the path length over which diffusion acts is impossible to accurately predict. Although it is difficult to demonstrate that this assumption is strictly conservative, it seems reasonable to assume—given the density of Series 743 waste in the described area—that the average distance of a given dig face to some source material will be greater than 0.5 m (1.6 ft). Furthermore, the air-phase concentration of CCl_4 (260 g/m³) used, in conjunction with this assumed diffusion path length, to calculate a diffusive flux has been previously characterized as being highly conservative.

At a short-term CCl_4 emission rate of 2.05 g/second and a bulk airflow rate of 20,000 actual ft³/minute (acfm) from the Retrieval Enclosure Exhaust port, the CCl_4 concentration at the point of release (at 25°C) would be approximately 41 ppmv.

A-5. CONCLUSIONS

Applying highly conservative assumptions, it is estimated that the long-term CCl_4 emission rate corresponding for the public receptor (i.e., AACC) is approximately 1.95 g/second. Applying moderately conservative assumptions, it is estimated that the short-term CCl_4 emission rate corresponding to the collocated worker (i.e., OEL) is approximately 2.05 g/second. Based on these emission rates and an estimated bulk airflow of 20,000 acfm from the Retrieval Enclosure exhaust port, the resulting stack concentrations of CCl_4 would be approximately 39 ppmv for the long-term emission rate and 41 ppmv for the short-term emission rate. Typically short-term emission rates would exceed long-term emission rates by a significant margin (e.g., factor of 5). However, the different levels of conservatism for the long-term (i.e., highly conservative) and short-term (i.e., moderately conservative) emission-rate estimates account for the atypical similarity in these estimates.

A-6. REFERENCES

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